# Numerical inversion and modeling of 1993-97 GPS data at Mount Etna, Italy

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Since 1993 geodetic data obtained by different techniques (GPS, EDM, SAR, leveling) detected a consistent inflation of the Mount Etna volcano. The inflation, culminated with the 1998-2001 strong explosive activity from summit craters and recent 2001 and 2002 flank eruptions, may be interpreted by magma ascent and re-filling of the volcanic plumbing system and reservoirs. Our purpose is to model the 1993-97 GPS data by pressurized sources simulating the magma reservoir using a 3D Finite Element modeling coupled to a Monte Carlo inversion. The power of this technique, if compared with analytical inversions, is that sources can be placed in complex media (heterogeneous, with topography, inelastic etc.) so that the inversion result is not influenced by the usual approximations of elastic, homogeneous half-space.

The FE model of Mt. Etna is characterized by a regular mesh below the volcanic edifice, and by arbitrarily distorted brick elements elsewhere. The potential point sources are contained in a volume of 64 km$^3$, subdivided into $10\times10\times10$ elements, and located below the summit craters, between 3 km and 7 km b.s.l.. Source parameters are obtained as a linear combination of the 6 solutions (one for each stress component) computed for each of the 1000 potential sources at the GPS observation points. The best fitting source search is performed by the Neighbourhood Algorithm inversion technique.

Synthetic test for a spherical/ellipsoidal source show a best-fit model with a $\chi^2$ misfit as low as 0.1. The method is then applied to find the best source responsible for the 1993-97 GPS deformation. We consider four classes of models characterized by: i) homogeneous medium and flat free surface; ii) homogeneous medium with topography of Mt.Etna; iii) heterogeneous medium with flat free surface; iv) heterogeneous medium with topography. Solutions are compared also with those derived by inversions of analytical forward models in the homogeneous medium with flat free surface, showing good agreement. Differences in source parameters arising from the characteristics of the medium are also discussed.